Space Weather Technical Forecast

Issued on Thursday 28 November 2024 at 00:59 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Mainly Moderate Activity. CME arrival day 1 (28 Nov) with G1-G2 Minor/Moderate Storms likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one M1.0 flare observed at 27/1246 UTC from AR3911 in the southwest. This is a relatively small but newly developed region, but has since shown some decay. There are eleven active regions currently on the Earth-facing disc, with the largest of these forming a pair of region in the south-centre disc, AR3905 and AR3906. Despite being moderately sized, these are magnetically relatively simple, and have been largely inactive. The other region of note is AR3910 in the northeast, which produced an M9 flare on 25 Nov from over the northeast limb. This appears to be a relatively simple region, however further details still have the potential to become apparent as this moves to a less oblique viewing angle.

A filament eruption was observed off the southeast disc at 27/1850 UTC in H-alpha imagery, with a subsequent CME becoming visible on recent SOHO coronagraphs, heading south and east. This remains under analysis for any Earth-directed component. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Slow wind conditions persisted. Solar wind speeds measured by ACE at L1, were at background, around 350km/s with density around or below average. Interplanetary Magnetic Field, Bt, was Weak throughout, peaking at 7nT. The north-south component, Bz, varied weakly between +7/-6nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at Background. High energy electron flux (greater than 2MeV) observed by GOES16 was at background. The associated 24-hour fluence remained well below the Active threshold. The integrated flux observed at 28/0000 UTC was 2.04e6 total pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with isolated M-class flares. There is a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: CME from the filament eruption on 25 Nov is expected to arrive on day 1 (28 Nov), but low confidence on timing and impact of this feature, with the bulk of

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its material passing south and east. Otherwise, mainly background winds are expected. Initially Quiet geomagnetic activity, but with a likelihood of a period of Active to G1 Minor Storms from the CME arrival on day 1 (28 Nov). There is slight chance of G2 Moderate Storms, primarily later in the day from any following magnetic cloud. CME enhancements then easing day 2 (29 Nov) with mainly Quiet to Unsettled conditions following.

Energetic Particles / Solar Radiation: High energy protons are expected to persist at Background but with a slight chance of rising in response to any notable flares. High energy electron flux is expected to persist at mainly Background with the associated 24 hour fluence remaining below the Active threshold.

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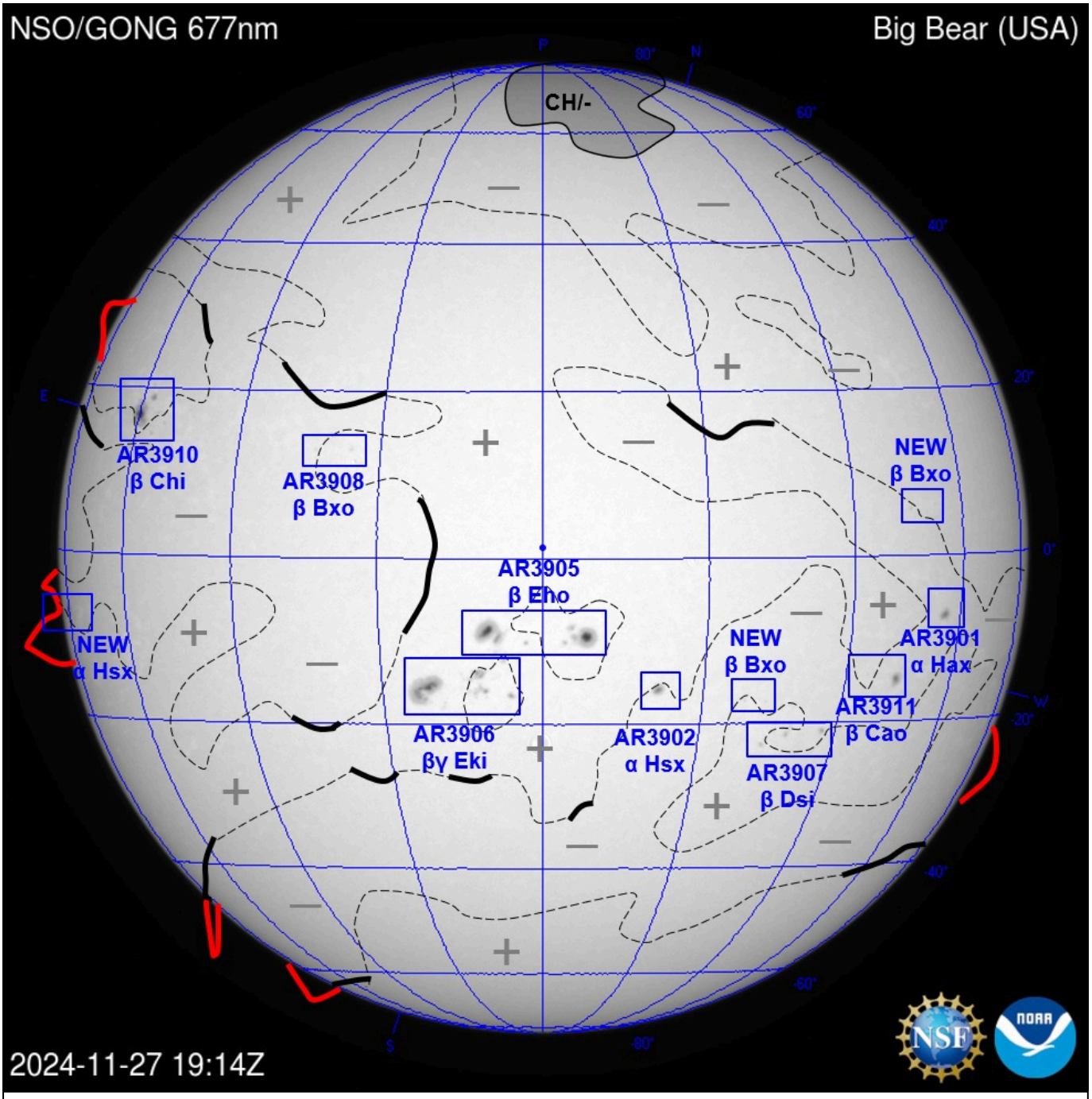
Figure 1: MOSWOC Solar Synoptic Map 27/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are a couple of CMEs of interest. The most notable is from the filament eruption around 25/2030 UTC. The majority of the bulk ejecta is directed south and east, however a partial halo shock component is also evident. There is a moderate confidence for at least a glancing impact on day 1 (28 Nov), most likely around 28/0700 UTC, however the timing is lower confidence due to MOSWOC Enlil currently providing poor guidance due to a large overestimated fast wind sector, and due to this, there is some potential for the arrival to not occur until later in the day.

The second CME is yet to be analysed, and was observed leaving the Sun due to a filament eruption from the southeast disc around 27/1850 UTC.

While a number of other CMEs have been observed on previous days these are either missing Earth, or are narrow, slow and expected to give at most glancing impacts given their trajectory. Any arrival is likely to be largely imperceptible and, given largely background winds are expected through the period, unlikely to bring more than very slight geomagnetic enhancements.

Geomagnetic activity is expected to be mainly Quiet (Kp 0-2) at first. The CME arrival on day 1 (28 Nov) is likely to bring Active to G1 Minor Storms, with a slight chance for isolated G2 Moderate Storm intervals. This most likely if any prolonged negative (southward) orientated north-south component of the IMF is observed with any magnetic cloud that follows the arrival later in the day. Any enhancement is expected to ease from early day 2 onward, with mainly Quiet to Unsettled conditions following, with only a slight chance of Active intervals.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	30	5	5
Strong	G3	No	10	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-11-25 20:30	Partial	AR3901	SE	950	28/11/2024 07:00 UTC	+/- 8 hours

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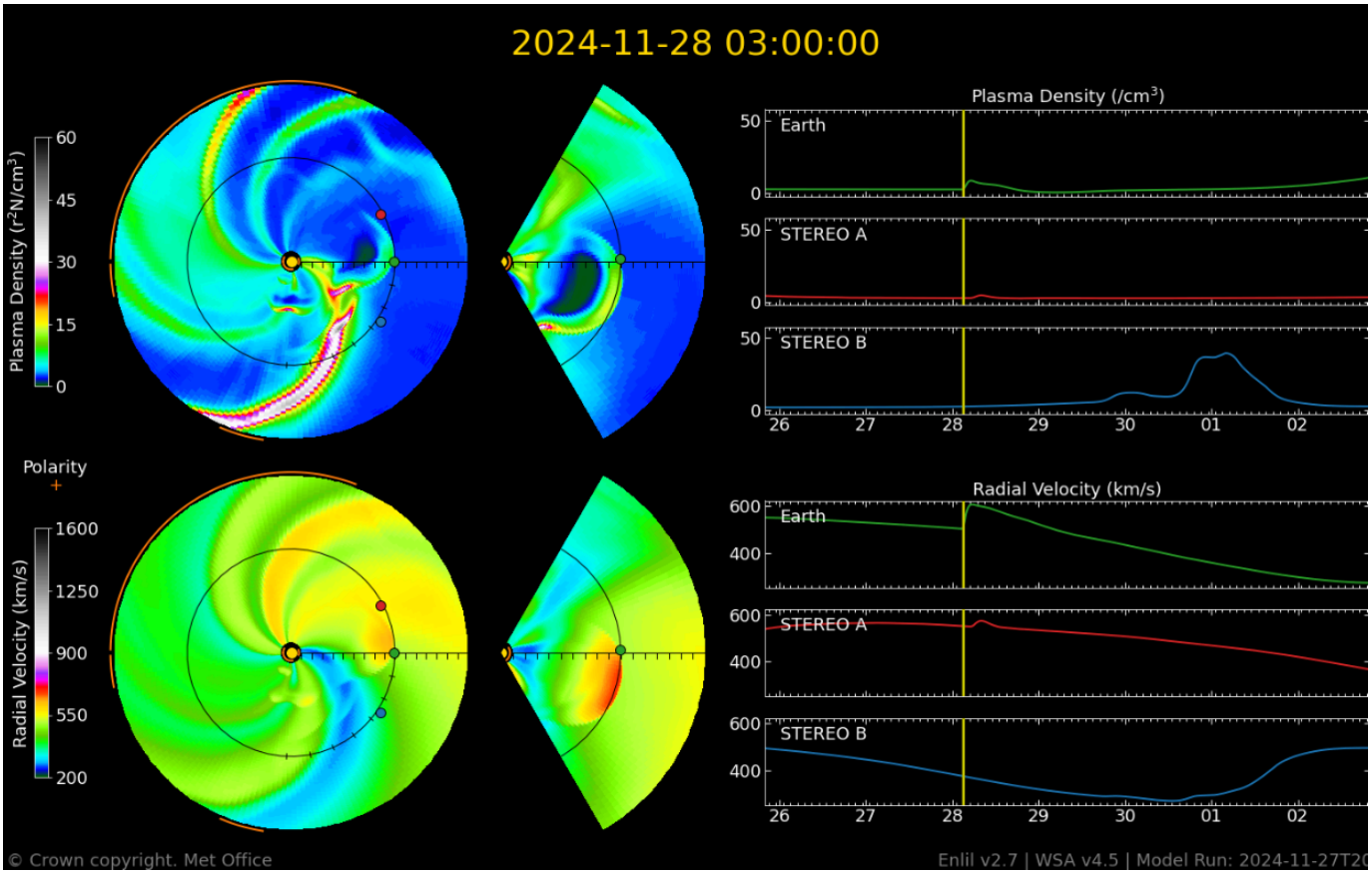
Figure 2: MOSWOC Enlil. Arrival of CME early 28 Nov in model is considered too fast, due travelling through a broad sector of fast wind that has not been observed.



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Radio Blackouts - X-Ray Flares

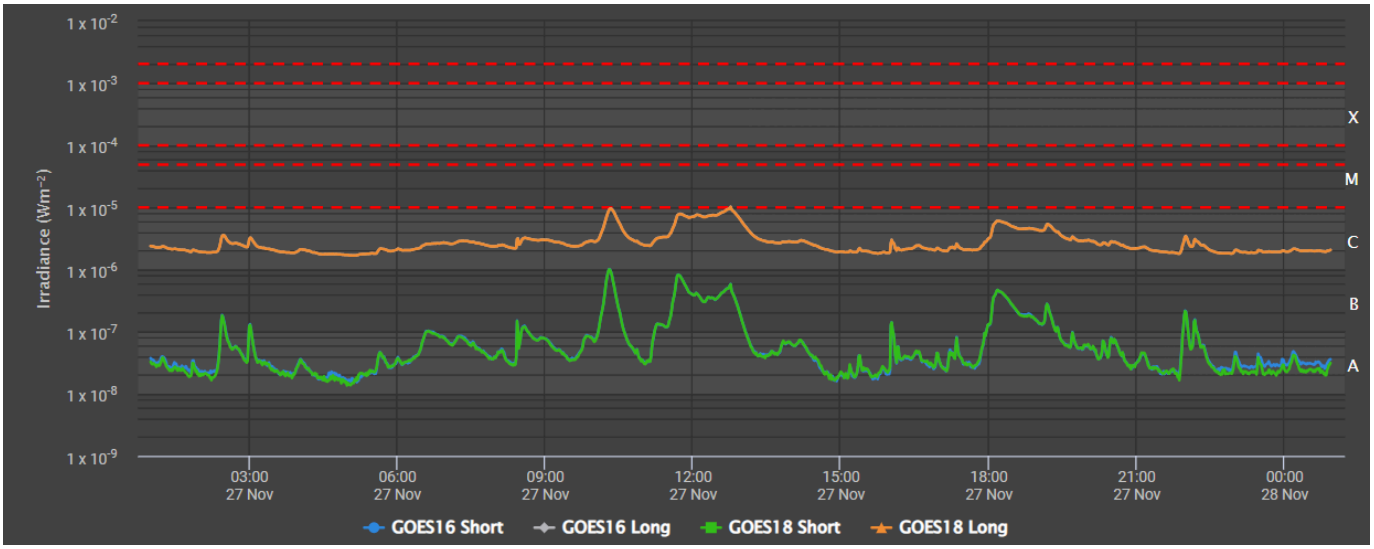
Mainly Moderate activity is expected with isolated M-class flares expected, and a slight chance of X-class flares.

There are eleven sunspot regions on the Earth-facing disc, however these are generally simple, with no clear delta-spots currently evident. The largest and most notable regions are AR3905 and AR3906 in the south-centre disc, however recent activity from these regions has been limited. Furthermore, some spreading and simplification of AR3905 has been evident with a reduction in the number of intermediate small spots.

Also of note is AR3910 in the northeast. This region produce an M9.4 flare on 25 Nov from over the northeast limb, and while this appears to be only a moderately sized and relatively simple spot, further details are likely to become apparent as this moves into a clearer viewing angle. The source of the only M-flare of the last 24 hours was AR3911 in the southwest, however this appears to have subsequently simplified.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 3: GOES 16/18 X-ray Irradiance



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Solar Radiation Storms (High Energy Protons)

GOES-18 Proton flux is at Background. There are a number of active regions currently on the disc, with the largest of these situated in the south-centre and soon to move into the southwestern hemisphere increasing their potential connectivity. However, being moderately sized, the regions remain magnetically simple, and subsequently only have a slight chance of observable high energy protons being ejected from any event that does occur.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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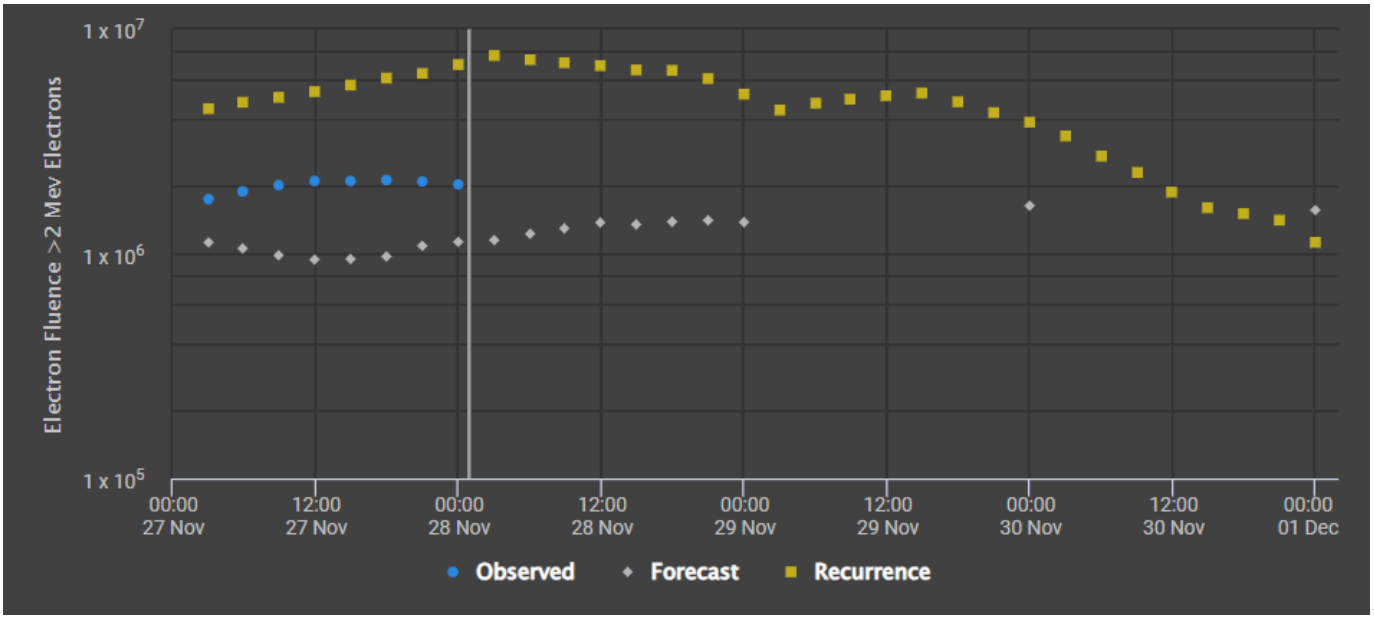
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES-16 is at Background and is expected to persist at this level, with no significant enhancements currently anticipated. The expected CME arrival on day 1 (28 Nov) is not expected to have a notable impact on the observed flux levels at GEO.

The associated 24 hr fluence is expected to persist below Active, with MOSWOC REFM currently providing good guidance.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^8**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ 1×10^9**	No	1	1	1	1

Figure 4: GOES16 Electron Fluence, with REFM and Persistence



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